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Tsuchiya

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(54) **COMMUNICATION CONVERSION SYSTEM FOR SWITCHING FIRST COMMUNICATION LINES TO SECOND COMMUNICATION LINES BASED ON CHANGE IN VOLTAGE STATE OF DETECTION-USE PIN**

(75) Inventor: **Shusuke Tsuchiya**, Tokyo (JP)

(73) Assignee: **Olympus Medical Systems Corp.** (JP)

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(22) Filed: **Mar. 5, 2008**

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G06F 13/12 (2006.01)
A61B 1/00 (2006.01)

(52) **U.S. Cl.** **710/72**; 710/8; 710/9; 710/10; 710/14; 710/15; 710/16; 710/17; 710/18; 710/19; 710/62; 370/241; 370/467; 455/436; 455/466

(58) **Field of Classification Search** 710/8–10, 710/14–19, 62, 72; 370/241, 467; 455/436, 455/466
See application file for complete search history.

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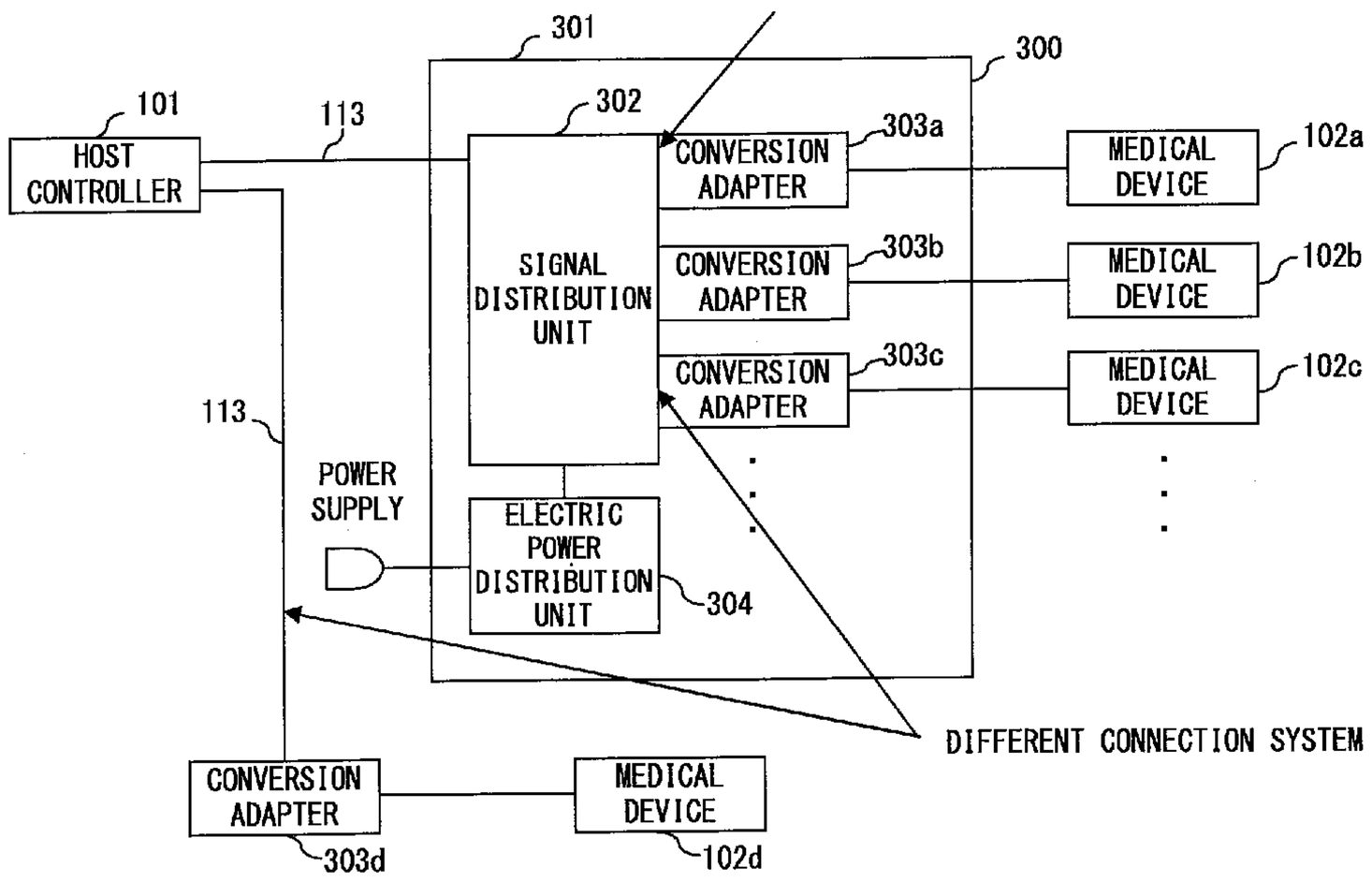
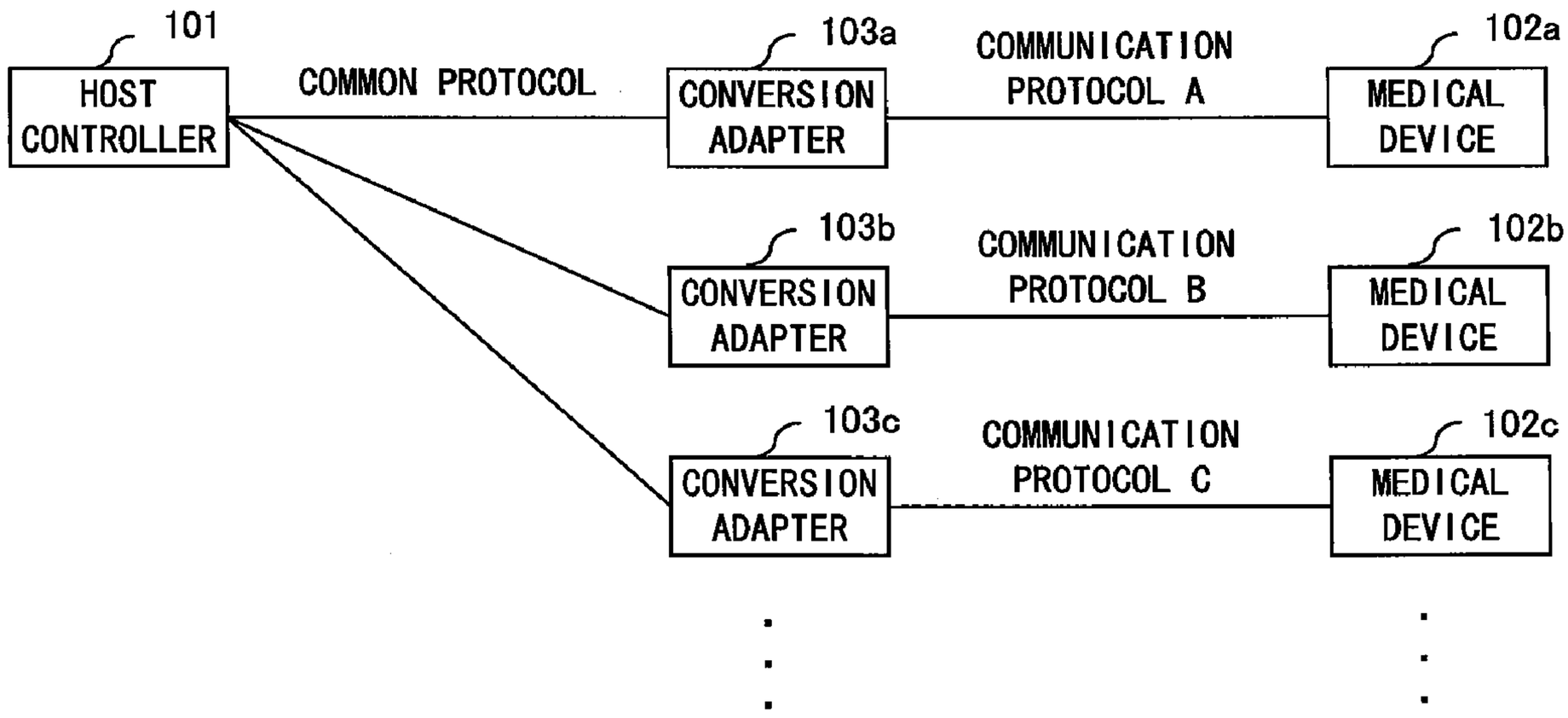
Primary Examiner—Tammara Peyton
(74) *Attorney, Agent, or Firm*—Ostrolenk Faber LLP

(57) **ABSTRACT**

A communication converter includes: a first communication interface making capable of communicating with a medical control device through a predetermined communication cable; a second communication interface making capable of making a connection to a signal distribution unit which is provided in a housing device capable of housing one or more communication converters, and distributes a signal from the medical control device to each of the communication converters; a switch unit for switching communication lines to either a communication line through the first communication interface or a communication line through the second communication interface; a detection unit for detecting whether or not the signal distribution unit is connected to the second communication interface; a switch control unit for controlling the switch unit based on a detection result; and a third communication interface making capable of performing communications with a medical device.

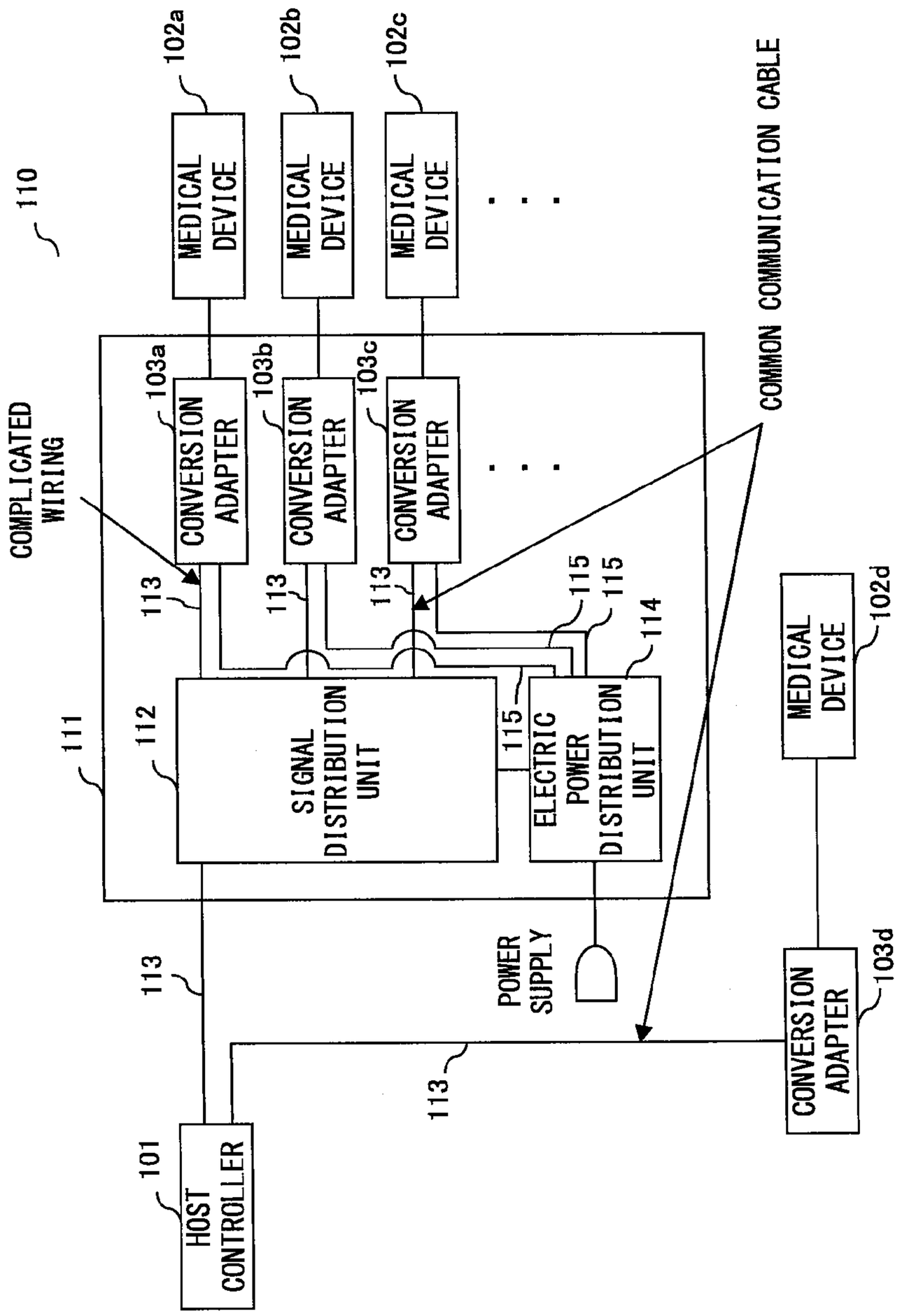
3 Claims, 9 Drawing Sheets





PRIOR ART

FIG. 1



PRIOR ART

FIG. 2

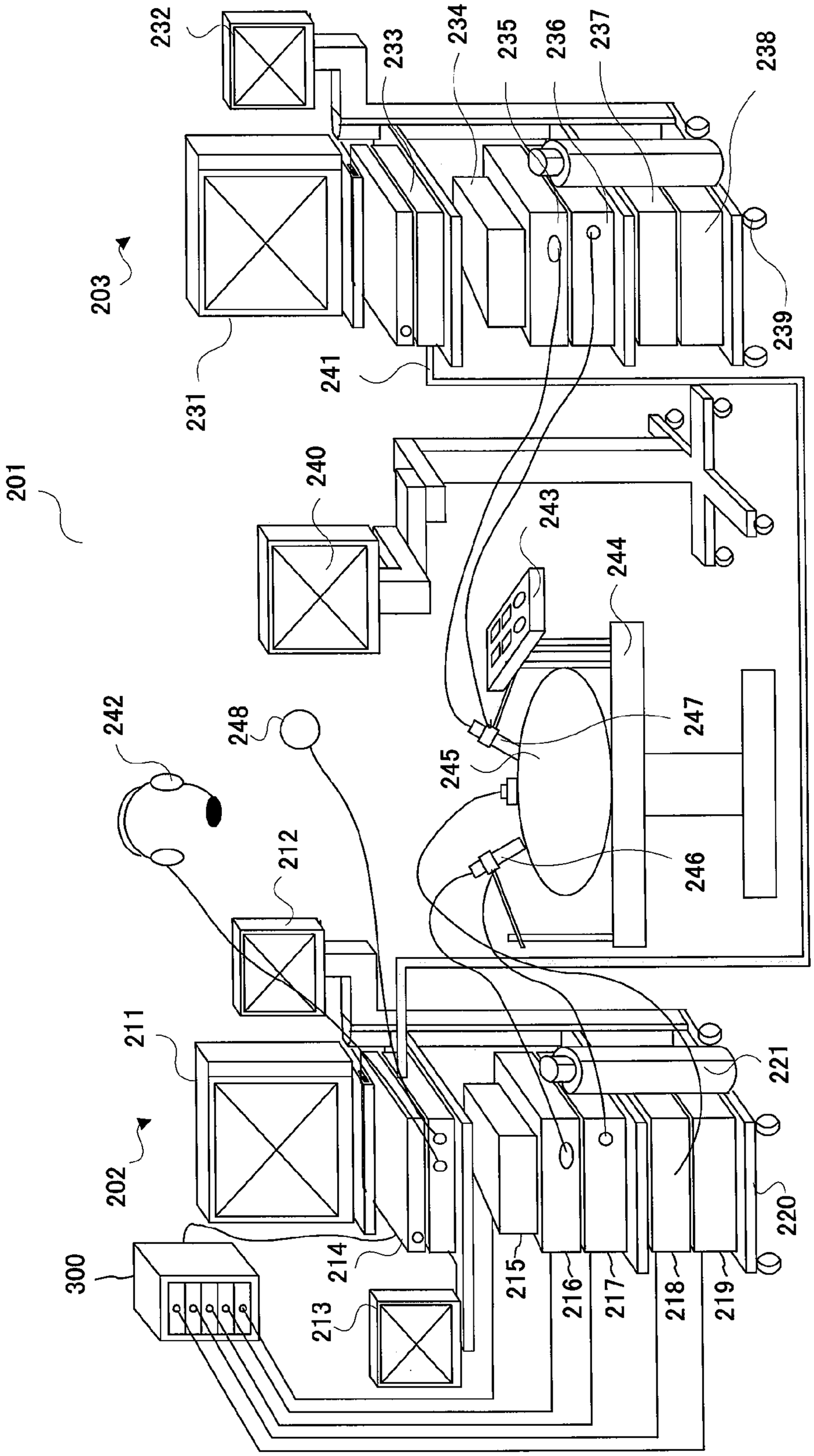

232
233
234
235
236
237
238
239
203
241
231
201
240
243
244
242
248
247
245
246
212
211
221
202
220
300
214
215
216
217
218
219
213

FIG. 3

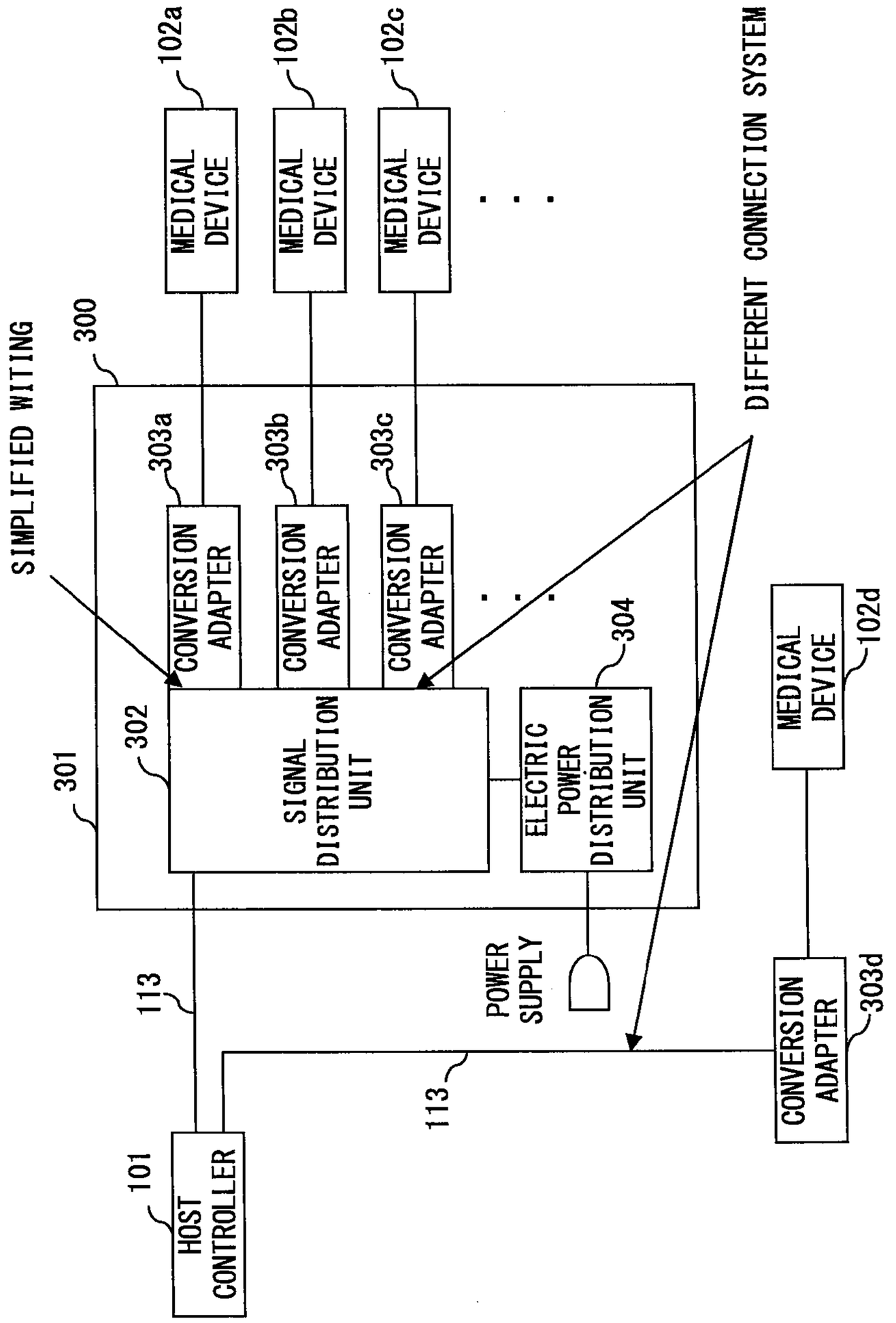

HOST CONTROLLER
101
113
SIMPLIFIED WITING
300
301
302
SIGNAL DISTRIBUTION UNIT
ELECTRIC POWER DISTRIBUTION UNIT
304
POWER SUPPLY
CONVERSION ADAPTER
303a
303b
303c
303d
MEDICAL DEVICE
102a
102b
102c
102d
DIFFERENT CONNECTION SYSTEM

FIG. 4

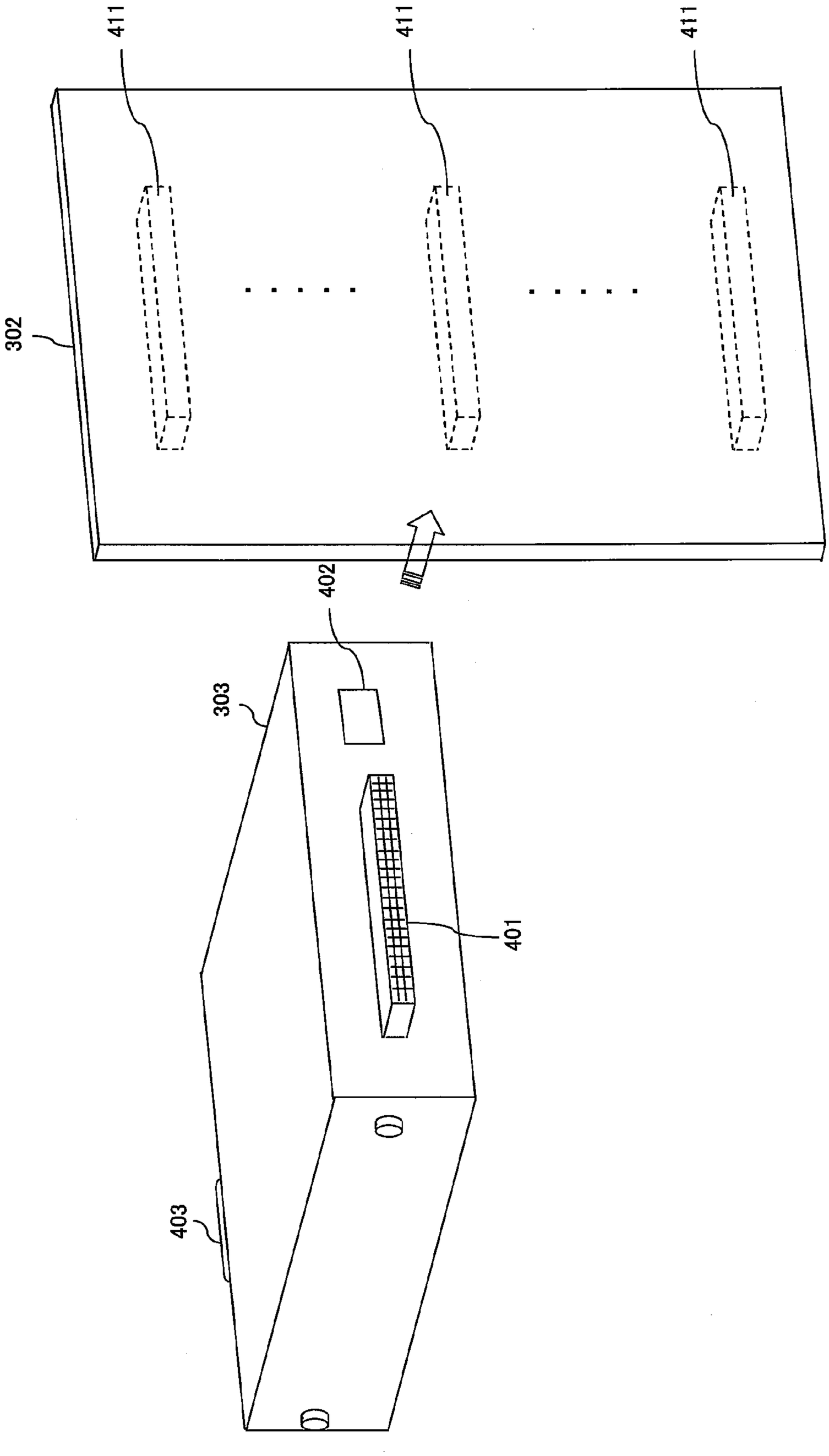


FIG. 5

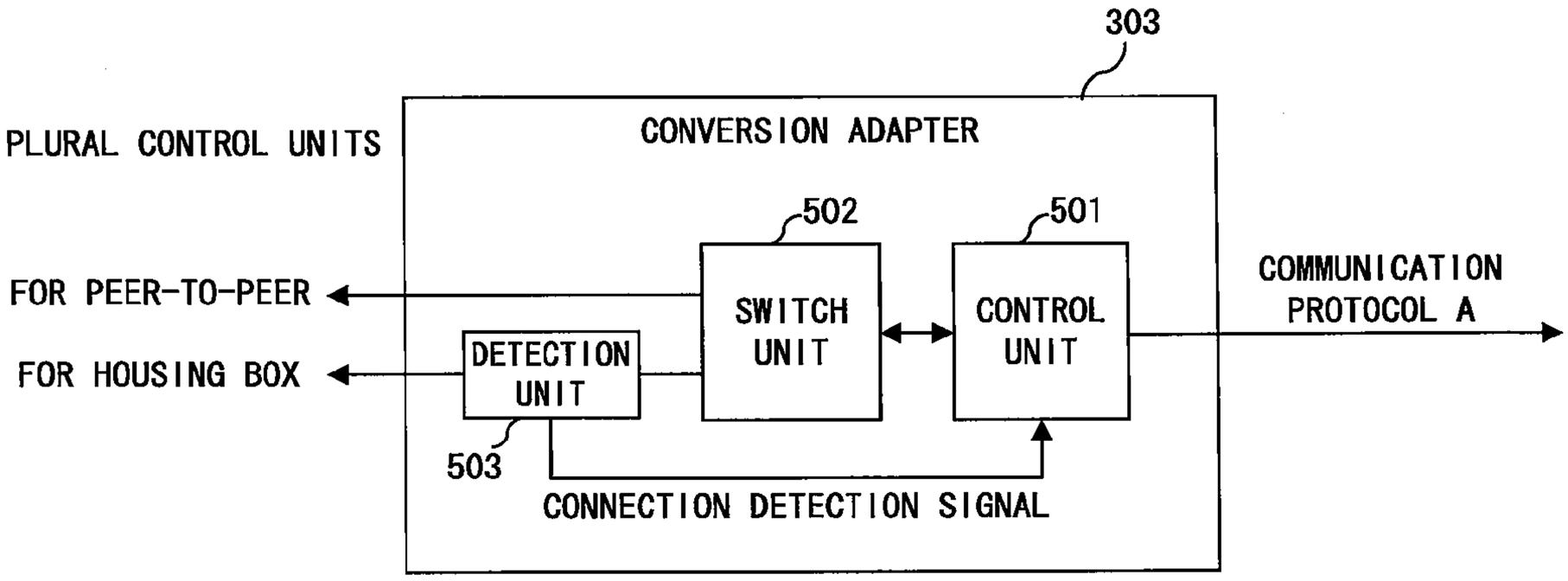

303
PLURAL CONTROL UNITS
CONVERSION ADAPTER
502
501
FOR PEER-TO-PEER
SWITCH UNIT
CONTROL UNIT
COMMUNICATION PROTOCOL A
FOR HOUSING BOX
DETECTION UNIT
503
CONNECTION DETECTION SIGNAL

FIG. 6

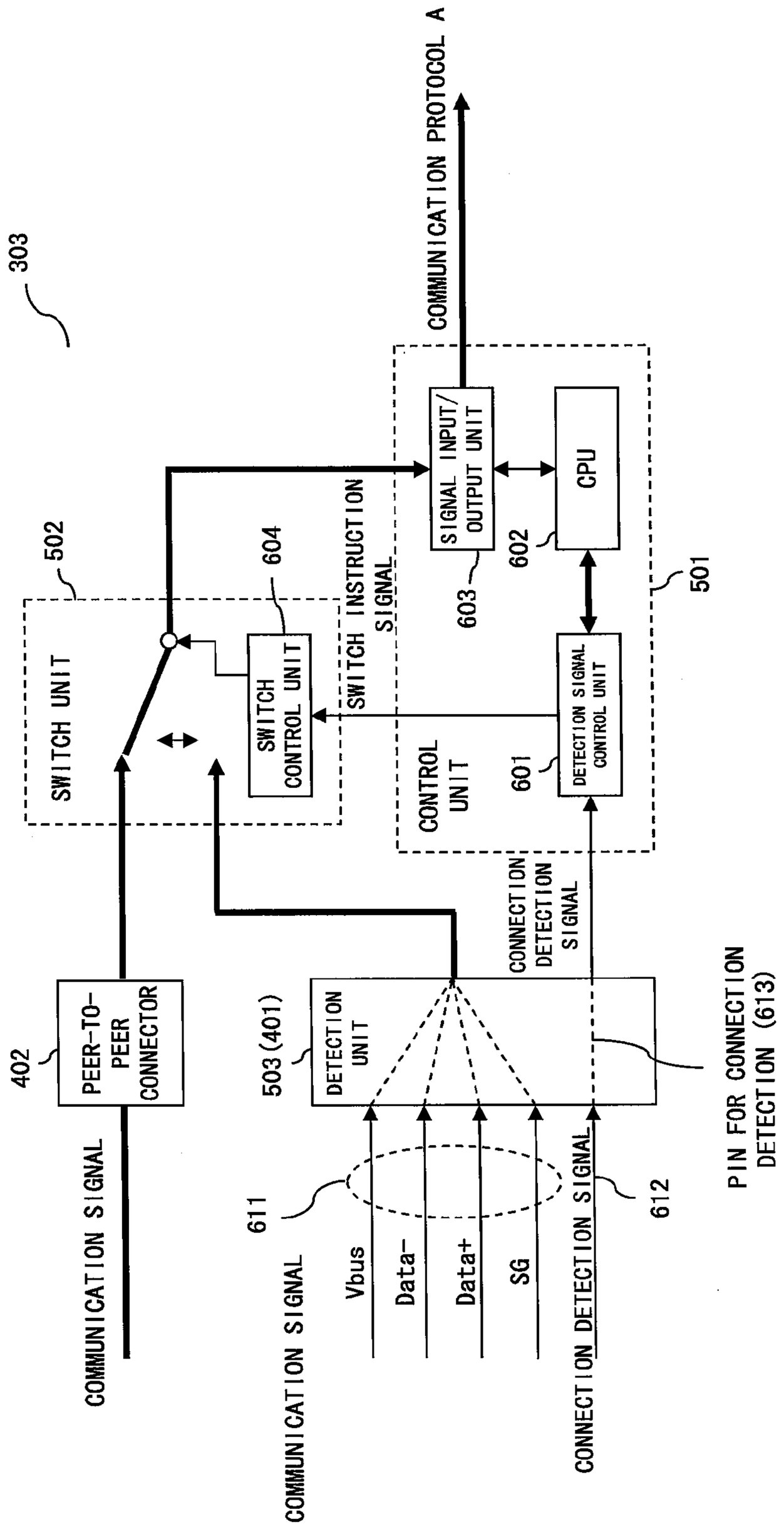

303
COMMUNICATION PROTOCOL A
SIGNAL INPUT/ OUTPUT UNIT
CPU
602
603
501
502
604
SWITCH INSTRUCTION SIGNAL
SWITCH UNIT
SWITCH CONTROL UNIT
CONTROL UNIT
601
DETECTION SIGNAL CONTROL UNIT
CONNECTION DETECTION SIGNAL
402
PEER-TO-PEER CONNECTOR
503 (401)
DETECTION UNIT
PIN FOR CONNECTION DETECTION (613)
COMMUNICATION SIGNAL
611
Vbus
Data−
Data+
SG
CONNECTION DETECTION SIGNAL
612

FIG. 7

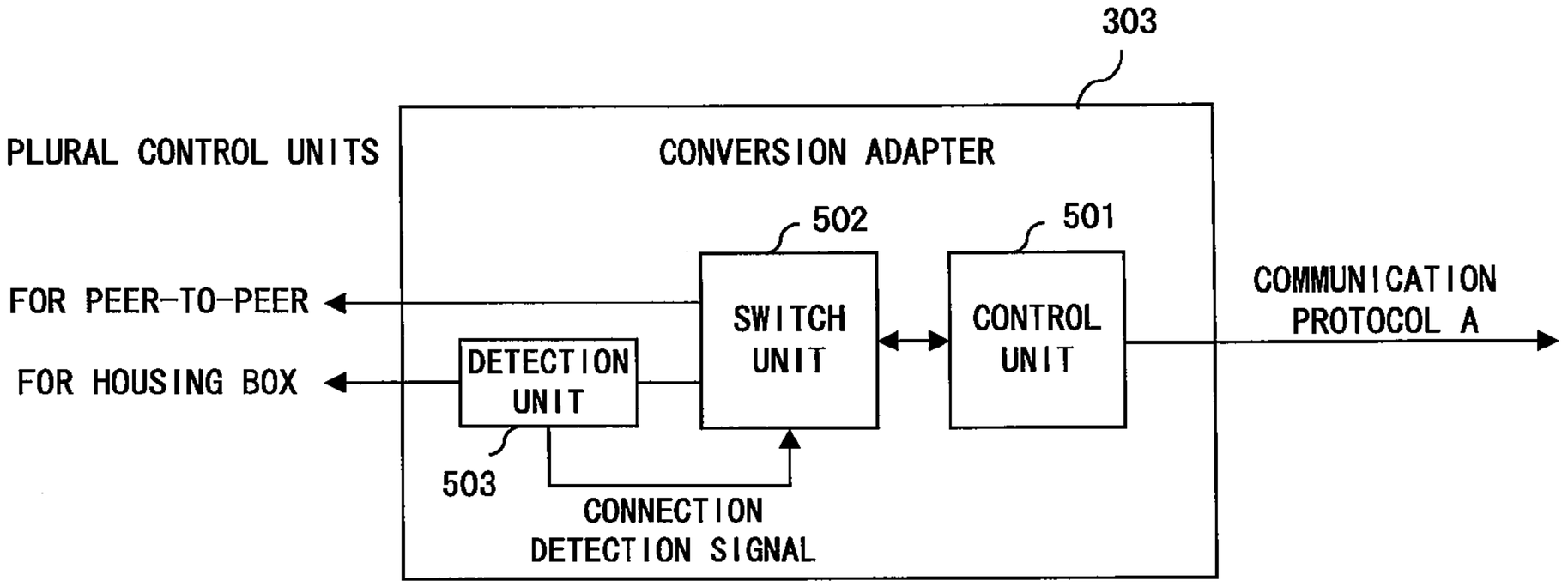

303
PLURAL CONTROL UNITS
CONVERSION ADAPTER
502
501
SWITCH UNIT
CONTROL UNIT
COMMUNICATION PROTOCOL A
FOR PEER-TO-PEER
FOR HOUSING BOX
DETECTION UNIT
503
CONNECTION DETECTION SIGNAL

FIG. 8

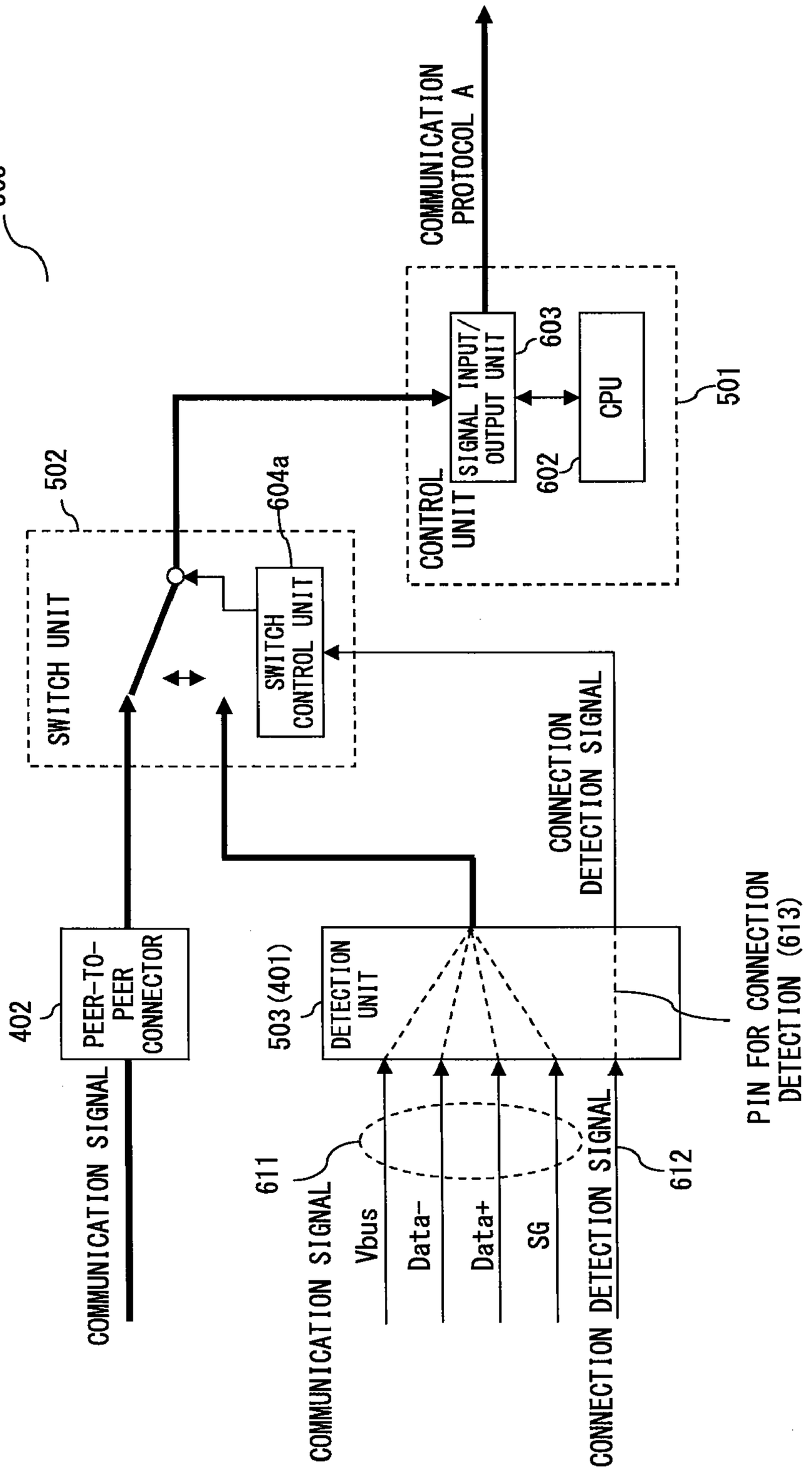

303
COMMUNICATION PROTOCOL A
CONTROL UNIT
SIGNAL INPUT/ OUTPUT UNIT
603
CPU
602
501
502
SWITCH UNIT
604a
SWITCH CONTROL UNIT
CONNECTION DETECTION SIGNAL
402
PEER-TO-PEER CONNECTOR
503 (401)
DETECTION UNIT
COMMUNICATION SIGNAL
611
Vbus
Data-
Data+
SG
CONNECTION DETECTION SIGNAL
612
PIN FOR CONNECTION DETECTION (613)

FIG. 9

COMMUNICATION CONVERSION SYSTEM FOR SWITCHING FIRST COMMUNICATION LINES TO SECOND COMMUNICATION LINES BASED ON CHANGE IN VOLTAGE STATE OF DETECTION-USE PIN

FIELD OF THE INVENTION

The present invention relates to a communication converter which connects a plurality of medical devices to a medical control device for controlling the medical devices.

BACKGROUND OF THE INVENTION

Recently, surgery is performed using an endoscope operation system having a plurality of medical devices. In an endoscope operation system, when an organization of a living body is removed using an insufflation device for expanding a visceral cavity and a treating device etc. for treating an affected part, and hemostasis is performed using a high frequency cautery device, these treatments can be performed while watching images captured by an endoscope.

The endoscope operation system includes a plurality of medical devices for an endoscope operation, and a system controller for controlling the medical devices, a display operation device, etc. Thus, the endoscope operation system is configured by a plurality of devices, and it is necessary to use a common communication protocol to enable communications between the devices. However, manufacturers of medical devices adopt different communication methods and/or communication protocols for their own medical devices. Therefore, a communication converter is used to convert the communication methods and/or communication protocols to enable communications to be performed between them.

The communication system refers to a system of communications based on the physical or electrical configuration of communications such as infrared communications, USB (Universal Serial Bus) communications, RS-232C communications, Controller Area Network (CAN), or Ethernet communications, etc. A difference in communication system refers to a difference in physical or electrical standards in various communications such as a difference between wireless communication and cable communication, a difference in shape of a connector, etc. (therefore, the difference disables a physical or electrical connection to be performed). A communication protocol refers to a normally adopted communication protocol, that is, a logical connection, as compared with the physical or electrical connection in the above-mentioned communication system.

SUMMARY OF THE INVENTION

The communication converter according to the present invention which converts a communication system and/or a communication protocol to enable communications to be performed between a medical device and a medical control device for controlling the medical device includes:

a first communication interface making capable of communicating with the medical control device through a predetermined communication cable;

a second communication interface making capable of making a connection to a signal distribution unit which is provided in a housing device capable of housing one or more communication converters, and distributes a signal from the medical control device to each of the communication converters;

a switch unit for switching communication lines to either a communication line through the first communication interface or a communication line through the second communication interface;

a detection unit for detecting whether or not the signal distribution unit is connected to the second communication interface;

a switch control unit for controlling the switch unit based on the detection result; and

a third communication interface making capable of performing communications with the medical device.

A communication conversion system according to the present invention includes:

a communication converter for converting a communication system and/or a communication protocol to enable communications between a medical device and a medical control device for controlling the medical device; and

a housing device capable or housing one or more communication converters.

With the configuration, the communication converter includes:

a first communication interface making capable of communicating with the medical control device through a predetermined communication cable;

a second communication interface for use in communicating with the medical control device when the communication converter is housed in the housing device;

a switch unit for switching communication lines to either a communication line through the first communication interface or a communication line through the second communication interface;

a detection unit for detecting whether or not a predetermined connector of the housing device is connected to the second communication interface;

a switch control unit for controlling the switch unit based on the detection result; and

a third communication interface making capable of performing communications with the medical device.

The housing device includes:

a plurality of connectors capable of attaching and removing the second communication interface of the communication converter; and

a signal distribution unit for distributing a signal from the medical control device to the communication converter attached to each of the connectors.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the connection of various medical devices of other manufactures to a host controller of a specific manufacturer;

FIG. **2** shows a conventional communication conversion system;

FIG. **3** shows the entire configuration of an endoscope operation system according to an embodiment of the present invention;

FIG. **4** shows a communication conversion system **300** of an embodiment of the present invention;

FIG. **5** is a perspective view of the housing of a conversion adapter **303** according to an embodiment of the present invention and shows an example of a connector of a signal distribution unit **302**;

FIG. **6** shows the outline of the internal configuration of the conversion adapter **303** according to an embodiment of the present invention;

FIG. **7** shows the details of the internal configuration of the conversion adapter **303** according to an embodiment of the present invention;

FIG. **8** shows the outline of the internal configuration of the conversion adapter **303** according to an embodiment (variation) of the present invention; and

FIG. **9** shows the details of the internal configuration of the conversion adapter **303** according to an embodiment (variation) of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows the connection of various medical devices of other manufactures to a host controller of a specific manufacturer in the conventional technology. Conventionally, when communications among medical devices of different manufactures are integrated, a host controller (system controller) is connected to a medical device through a communication conversion adapter (hereinafter referred to simply as a conversion adapter) because each manufacture uses quite different communication system or communication protocol to each other. FIG. **1** shows an example of connecting a medical device **102***a* of a manufacturer A, a medical device **102***b* of a manufacturer B, and a medical device **102***c* of a manufacturer C to a host controller **101** using conversion adapters **103***a*, **103***b*, and **103***c* corresponding to a communication system and a communication protocol of each manufacturer.

The host controller **101** can use a common communication protocol (hereinafter referred to as a common protocol) for the medical device of the manufacturer of the host controller, and communicate with a medical device having a communication standard corresponding to the common protocol.

On the other hand, the communication interface (I/F) of the medical device **102***a* of the manufacturer A uses a communication protocol A different from the common protocol and the communication protocols of other manufacturers. Therefore, it is necessary to connect the host controller **101** to the medical device **102***a* through the conversion adapter **103***a* for converting communication protocols between the common protocol and the communication protocol A.

In addition, the communication I/F of the medical device **102***b* of the manufacturer B uses a communication protocol B different from the common protocol and the communication protocols of other manufacturers. Therefore, it is necessary to connect the host controller **101** to the medical device **102***b* through the conversion adapter **103***b* for converting communication protocols between the common protocol and the communication protocol B.

The communication I/F of the medical device **102***c* uses the communication protocol C different from the common protocol and the communication protocols of other manufacturers. Therefore, it is necessary to connect the host controller **101** to the medical device **102***c* through the conversion adapter **103***c* for converting communication protocols between the common protocol and the communication protocol C.

Thus, when communications are integrated with the medical devices of other manufactures in the conventional technology, a dedicated conversion adapter is used for each of the medical devices of other manufactures.

FIG. **2** shows the conventional communication conversion system. A communication conversion system (hereinafter referred to as a conversion system) **110** is configured by a housing box **111** and the conversion adapters **103** (**103***a*, **103***b*, **103***c*, . . .). The host controller **101** and the medical devices **102** (**102***a*, **102***b*, **102***c*, . . .) are connected through the conversion system **110**. As described above, the respective communication protocol between the conversion adapters **103** (**103***a*, **103***b*, **103***c*, **103***d*, . . .) and the medical devices **102** (**102***a*, **102***b*, **102***c*, **102***d*, . . .) is different from the common protocol or the communication protocols of other manufacturers.

The housing box **111** can house a plurality of conversion adapters **103** (**103***a*, **103***b*, **103***c*, . . .). The housing box **111** includes a signal distribution unit **112**, and an electric power distribution unit **114**.

The signal distribution unit **112** is a concentrator for centrally connecting communication cables **113**. The signal distribution unit **112** is connected to each of the conversion adapters **103** (**103***a*, **103***b*, **103***c*, . . .) through the communication cable **113**. The signal distribution unit **112** is connected to the host controller **101** through the communication cable **113**. The signal distribution unit **112** can distribute and relays a signal from the host controller **101** to a predetermined medical device. The communication cable **113** is, for example, a cable for a Universal Serial Bus (USB).

The electric power distribution unit **114** supplies electric power to the signal distribution unit **112**, or supplies the power to each conversion adapter **103** through the power supply cable **115**.

The host controller **101** can be connected directly to the conversion adapter **103***d* connected to the medical device **102***d* through the communication cable **113**.

Thus, in the conventional technology, the conversion adapter **103** is housed in the housing box **111** to prevent the complicated operations in case the number of uses of the conversion adapter **103** increases. However, since the signal distribution unit **112** in the housing box **111** is conventionally connected to the conversion adapter by a communication system unique to the conversion adapter, it is necessary to make the connection by using the communication cable **113**. Additionally, it is necessary to connect the electric power distribution unit **114** to each conversion adapter **103** through the power supply cable **115** to supply electric power to each conversion adapter **103** in the housing box **111**. Therefore, in the housing box **111**, the wiring between the signal distribution unit **112** and the conversion adapters **103** becomes complicated because of many communication cables **113** and power supply cables **115**. As a result, the housing box **111** houses the communication cables **113** and the power supply cables **115**, thereby generating a large housing box **111**.

Described below is a conversion adapter with the optimum connection system added when a housing box houses a conversion adapter.

FIG. **3** shows the entire configuration of the endoscope operation system according to an embodiment of the present invention. A endoscope operation system **201** is provided on both sides of a bed **244** of a patient **245** with a first endoscope operation system **202**, a second endoscope operation system **203**, and an operator's wireless remote controller **243**.

In the endoscope operation systems **202** and **203**, a plurality of endoscope medical devices for performing an observation, inspection, processing, recording, etc. are loaded onto a first trolley **220** and a second trolley **239**. A movable stand is loaded with an endoscope display panel **240**.

The first trolley **220** includes an endoscope display panel **211**, a central display panel **212**, a central operation panel device **213**, a system controller **214**, a recorder **215**, a video processor **216**, an endoscope light source device **217**, an insufflation device **218**, and an electrical surgical device **219**.

The central operation panel device **213** is arranged in an unsterilized area, and nurses etc. centrally perform operations of medical devices. A mouse, a touch panel, etc. not shown in the attached drawings can be provided for the device. Using

the central operation panel device **213**, a medical device can be centrally managed, controlled, and operated.

The recorder **215**, the video processor **216**, the endoscope light source device **217**, the insufflation device **218**, and the electrical surgical device **219** are connected to the system controller **214** through the conversion system **300** to perform bi-directional communications with the system controller **214**.

Additionally, a head set type mike **242** can be connected to the system controller **214**. The system controller **214** recognizes the voice input from the head set type mike **242**, and can control each device by the voice of an operator. Furthermore, a speaker **248** can be connected to the system controller **214**.

The endoscope light source device **217** is connected to a first endoscope **246** through a light guide cable for transmitting illumination light. When the illumination light of the endoscope light source device **217** is supplied to the light guide of the first endoscope **246**, it illuminates the affected part etc. in the belly of the patient **245** into which the insertion part of the first endoscope **246** is needled.

The optical image data captured by the camera head of the first endoscope **246** is transmitted to the video processor **216** through the camera cable. The optical image data is signal-processed in the signal processing circuit in the video processor **216**, thereby generating a video signal.

The insufflation device **218** provides CO_2 gas from a gas tube **221** inside the belly of the patient **245**.

The second trolley **239** is loaded with an endoscope display panel **231**, a central display panel **232**, a expansion unit **233**, a recorder **234**, a video processor **235**, an endoscope light source device **236**, and other medical devices **237** and **238** (for example, a ultrasonic processing device, a lithotriosy device, a pump, a shaver, etc.). Each device is connected to the expansion unit **233** via a cable not shown in the attached drawings for bi-directional communications. The system controller **214** is connected to the expansion unit **233** by a expansion cable **241**.

The endoscope light source device **236** is connected to a second endoscope **247** through a light guide cable for transmitting illumination light. The illumination light of the endoscope light source device **236** is supplied to the light guide of the second endoscope **247**. Then, it illuminates the affected part etc. in the belly of the patient **245** into which the insertion part of the second endoscope **247** is needled.

The optical image data captured by the camera head of the second endoscope **247** is transmitted to the video processor **235** through a camera cable. The optical image data is signal-processed by the signal processing circuit in the video processor **235**, thereby generating a video signal. Then the video signal is output to the endoscope display panel **231**, and an endoscope image of an affected part etc. is displayed on the endoscope display panel **231**.

The system controller **214** can also be controlled by the operator's wireless remote controller **243** with which an operator performs the operation of the device from a sterilized area. In addition, the first trolley **220** and the second trolley **239** can be loaded with other devices (for example, a printer, an ultrasonic observation device, etc.).

FIG. **4** shows the communication conversion system **300** according to an embodiment of the present invention. In the descriptions below, the host controller **101** corresponds to the system controller **214** shown in FIG. **3**. The medical devices **102** (**102***a*, **102***b*, **102***c*, **102***d*, . . .) correspond to the recorder **215**, the video processor **216**, the endoscope light source device **217**, the insufflation device **218**, the electrical surgical device **219**, etc. shown in FIG. **3**. The host controller **101** is connected to the medical devices **102** (**102***a*, **102***b*, **102***c*, . . .) through the communication conversion system **300**. The connection between the host controller **101** and the communication conversion system **300** and the connection between the host controller **101** and the conversion adapter **303***d* are made through the respective communication cables **113** for communications using the common protocol.

The communication conversion system **300** is configured by the housing box **111**, the conversion adapters **303** (**303***a*, **303***b*, **303***c*, . . .), the signal distribution unit **302**, and the electric power distribution unit **304**. As described above, the conversion adapters **303** (**303***a*, **303***b*, **303***c*, **303***d*, . . .) and the medical devices **102** (**102***a*, **102***b*, **102***c*, **102***d*, . . .) respectively uses communication protocol different from the common protocol and communication protocols of other manufacturers.

A housing box **301** has a housing capable of storing a plurality of conversion adapters **303** (**303***a*, **303***b*, **303***c*, . . .). The front of the housing box **301** is open so that the conversion adapters can be attached and removed.

The substrate forming the signal distribution unit **302** is provided with a plurality of connectors for directly plugging the conversion adapters **303** (**303***a*, **303***b*, **303***c*, . . .). By plugging the conversion adapters **303** in the connectors, the signal distribution unit **302** can be bus-connected to the conversion adapters **303**. The signal distribution unit **302** is connected to the host controller **101** through the communication cable **113**. With the above-mentioned configuration, the signal distribution unit **302** can distributes a signal from the host controller **101** to the medical device **102**, and relays a signal from each medical device **102** to the host controller **101**.

The electric power distribution unit **304** adjusts the power acquired from the power supply, and supplies the adjusted power to each conversion adapter **303** connected to the signal distribution unit **302**. A predetermined pin among the pins of the connectors for connecting the signal distribution unit **302** to the conversion adapters **303** is used for power supply. The electric power distribution unit **304** supplies power to the conversion adapters **303** through the power supply lines and the power supply pins on the signal distribution unit **302**.

Thus, by adopting a communicating system for connection by directly plugging the conversion adapters **303** into the signal distribution unit **302** in addition to the connection system using a communication cable normally used for the conversion adapters **303**, the wiring between the conversion adapters **303** and the signal distribution unit **302** can be simplified.

FIG. **5** is a perspective view of a housing of the conversion adapter **303** and an example of a connector of the signal distribution unit **302** according to the present embodiment. The conversion adapter **303** is provided with a housing box connector **401**, a peer-to-peer connector **402**, and a medical device connecting connector **403**.

The housing box connector **401** makes a bus-connection to the signal distribution unit **302**. For example, it is a DIN connector. The peer-to-peer connector **402** makes a connection to the host controller using the common protocol. For example, it is a USB (type B) connector. The housing box connector **401** can plugs in any connector **411** in a plurality of connectors (for example, DIN connectors) **411** provided for the signal distribution unit **302**.

The medical device connecting connector **403** can deal with the communication system and the communication protocol of the medical device to be connected. The medical device connecting connector **403** can be connected to the communication cable **113**.

When a connection is made using the peer-to-peer connector **402**, a "one-to-one" connection can allow the host con-

troller to communicate with the medical device on a peer-to-peer (one-to-one) basis (refer to the conversion adapter **303***d* shown in FIG. **4**).

On the other hand, when a housing box connector is used for a connection, the host controller can communicate with each medical device by housing a plurality of conversion adapters in the housing box **301**. That is, the one-to-n (n is any integer) communication can be established (refer to the conversion adapters **303***a*, **303***b* and **303***c* shown in FIG. **4**).

FIG. **6** shows the outline of the internal configuration of the conversion adapter **303** according to an embodiment of the present invention. As shown in FIG. **6**, the conversion adapter **303** includes at least a control unit **501**, a switch unit **502**, and a detection unit **503**.

The detection unit **503** detects that the conversion adapter **303** plugs in the connector of the signal distribution unit **302**. When the detection unit **503** detects that the adapter plugs in the signal distribution unit **302**, it transmits a connection detection signal to the control unit **501**.

The control unit **501** includes at least a central processing unit (CPU), memory, etc. The control unit **501** controls the operation of each component configuring the conversion adapter **303**, reads and executes a program etc. stored in the memory, and converts communication protocols. The control unit **501** outputs a switch instruction signal to the switch unit **502** according to the connection detection signal from the detection unit **503**.

The switch unit **502** switches communication lines to activate one of the communication line through the housing box connector **401** and the communication line through the peer-to-peer connector **402** according to the switch instruction signal from the control unit **501**.

FIG. **7** shows the details of the internal configuration of the conversion adapter **303** according to an embodiment of the present invention. FIG. **7** shows the internal configuration shown in FIG. **6** in more detail. In the present embodiment, a DIN connector is used as an example of the housing box connector **401**. Through the DIN connector, communications can be established by a USB. The detection unit **503** corresponds to the housing box connector **401** (DIN connector), more practically, to a predetermined pin. When the housing box connector **401** is connected to the signal distribution unit **302**, the voltage level of the pin changes. The housing box connector **401** has a pin for a communication signal line **611** and a pin **613** for a connection detection signal line **612**. The communication signal line **611** is configured by two differential signal lines (D+, D−) and two power supply lines (Vbus, SG). The voltage of the connection detection signal line **612** changes from a high state to a low state when the housing box connector **401** is attached to the signal distribution unit **302**. The change of the voltage is output as a connection detection signal to the control unit **501** through the pin **613**.

The control unit **501** is configured by a detection signal control unit **601**, a CPU **602**, and a signal input/output unit **603**. The CPU **602** controls the detection signal control unit **601** and the signal input/output unit **603**, converts a communication protocol, and performs various other processes. The detection signal control unit **601** outputs a switch instruction signal to the switch unit **502** according to the connection detection signal from the detection unit **503**.

The switch unit **502** includes a switch control unit **604**. The switch control unit **604** switches between the communication line of the peer-to-peer connector **402** and the communication line of the housing box connector **401** according to the switch instruction signal from the detection signal control unit **601**.

Described next is the operation of the conversion adapter **303**. When the housing box connector **401** is not attached to the signal distribution unit **302**, the switch unit **502** switches to the peer-to-peer connector **402**. In this case, the conversion adapter **303** is connected to the communication cable **113** extending from the host controller **101** through the peer-to-peer connector **402**. A communication signal based on the common protocol from the host controller **101** is output to the signal input/output unit **603** through the peer-to-peer connector **402** and the switch unit **502**. The communication protocol of the control signal is converted by the CPU **602** from the common protocol to a predetermined communication protocol (for example, communication protocol A). The communication signal is output by the signal input/output unit **603** from the medical device connecting connector **403** to a medical device.

Next, when the housing box connector **401** plugs in the connector of the signal distribution unit **302**, the voltage of the connection detection signal line **612** changes from high level to low level, or from low level to high level. The change of the voltage is output as a connection detection signal to the detection signal control unit **601** through the pin **613**. The detection signal control unit **601** outputs a switch instruction signal to the switch control unit **604** according to the connection detection signal. The switch control unit **604** switches the communication line from the peer-to-peer connector **402** to the housing box connector **401** according to the switch instruction signal from the detection signal control unit **601**. In this case, the communication signal based on the common protocol from the host controller **101** is transmitted to the signal distribution unit **302** of the housing box **301**. The signal distribution unit **302** routes the communication signal, and outputs the signal to the conversion adapter **303** to which the destination medical device is connected. The communication signal is output to the signal input/output unit **603** through the housing box connector **401** and the switch unit **502**. The CPU **602** converts the communication protocol of the communication signal from the common protocol to a predetermined communication protocol (for example, a communication protocol A). The signal input/output unit **603** outputs the communication signal from the medical device connecting connector **403** to the medical device.

When the housing box connector **401** is removed from the signal distribution unit **302**, the voltage of the connection detection signal line **612** changes from low level to high level, and the change of the voltage is output as a connection detection signal to the detection signal control unit **601** through the pin **613**. The detection signal control unit **601** outputs a switch instruction signal to the switch control unit **604** according to the connection detection signal. The switch control unit **604** switches the communication line from the housing box connector **401** to the peer-to-peer connector **402** according to the switch instruction signal from the detection signal control unit **601**.

According to the configurations shown in FIGS. **6** and **7**, since the control unit **501** performs switch control, the control is performed independent of the specifications of the switch unit **502**. That is, by providing the detection signal control unit **601**, the detection signal control unit **601** can output a signal based on the specifications of the switch control unit **604** when the connection detection signal is received. That is, the CPU **602** can control the switch unit **502** with programmability.

Thus, by adding to the conversion adapter the optimum connecting method when the conversion adapter is stored in the housing box, the connections of the power supply cables and the communication cables can be simplified. In addition,

since the present invention can also be applied to the conventional connection system, the optimum layout can be structured for each hospital.

Described next is an example of a variation of an embodiment of the present invention. In the following descriptions, only the portions different from the above-mentioned embodiments are described, and the same descriptive portions are omitted.

FIG. **8** shows the outline of the internal configuration of the conversion adapter **303** according to an embodiment (variation example) of the present invention.

The difference between FIGS. **6** and **8** is that the connection detection signal is output from the detection unit **503** to the switch unit **502**.

FIG. **9** shows details of the internal configuration of the conversion adapter **303** according to an embodiment (variation example) of the present invention. FIG. **9** shows the internal configuration shown in FIG. **8** in more detail. The differences between FIGS. **7** and **9** are that the control unit **501** includes no detection signal control unit **601**, and a connection detection signal is output from the detection unit **503** to a switch control unit **604***a*.

The switch control unit **604***a* switches between the communication line of the peer-to-peer connector **402** and the communication line of the housing box connector **401** according to the connection detection signal from the detection unit **503**. Other operations are the same as those shown in FIG. **7**.

According to the embodiment, as compared with FIGS. **6** and **7**, the configuration of the control unit **501** can be simpler. However, it depends on the specifications of the switch unit **502**.

According to the present embodiment, the communication conversion system includes a communication converter and a housing device. The communication converter can convert a communication system and/or a communication protocol to enable communications between a medical device and a medical control device for controlling the medical device. The housing device can house one or more communication converters.

The communication converter, in the present embodiment for example, corresponds to the conversion adapter **303**. The communication converter includes a first communication interface, a second communication interface, a switch unit, a detection unit, a switch control unit, and a third communication interface.

The first communication interface enables communications with the medical control device through a predetermined communication cable. The first communication interface corresponds to the peer-to-peer connector **402** according to the present embodiment for example.

The second communication interface is used for communications with the medical control device when the communication converter is stored in the housing device. The second communication interface corresponds to the housing box connector **401** according to the present embodiment for example.

The switch unit switches communication lines to either the communication line through the first communication interface or the communication line through the second communication interface. The switch unit corresponds to the switch unit **502** according to the present embodiment for example.

The detection unit detects whether or not the signal distribution unit is connected to the second communication interface. The detection unit corresponds to the detection unit **503** according to the present embodiment for example.

The switch control unit controls the switch unit based on the detection result. The switch control unit corresponds to the detection signal control unit **601** or the switch control unit **604***a* according to the present embodiment.

The third communication interface enables communications with the medical device. The third communication interface corresponds to the medical device connecting connector **403** according to the present embodiment for example.

The housing device corresponds to the housing box **111** according to the present embodiment for example. The housing device includes a plurality of connectors and a signal distribution unit.

The connector can be attached and removed to and from the second communication interface of the communication converter. The second communication interface is connected to the connector using a connection system in which a connector format (for example, a bus connection system) is different from that of the first communication interface. The connector corresponds to the connector **411** according to the present embodiment for example.

The signal distribution unit distributes a signal from the medical control device to a communication converter attached to each connector. The signal distribution unit corresponds to the signal distribution unit **302** according to the present embodiment for example.

According to the present embodiment, the conversion adapter is provided with a communication interface capable of dealing with a connection system for peer-to-peer (one-to-one) and also a connection system for a housing box (one-to-n) (n is an arbitrary integer). Thus, by adding to the conversion adapter the optimum connection system when it is housed in the housing box, the connections of the power supply cables and the communication cables can be simplified, thereby downsizing the housing box. Depending on the connection environment of the host controller and the medical device in each hospital and the mounting space of a housing box, a connection system to be used can be selected. Thus, the optimum layout can be structured for each hospital.

What is claimed is:

1. A communication converter which converts a communication system and/or a communication protocol to enable communications between a medical device and a medical control device for controlling the medical device, comprising:

a first communication interface configured and operable for communicating with the medical control device through a predetermined communication cable;

a second communication interface configured and operable for making a connection to a signal distribution unit which is provided in a housing device capable of housing one or more communication converters, and distributes a signal from the medical control device to each of the communication converters;

a switch unit for switching communication lines to either a first communication line through the first communication interface or a second communication line through the second communication interface;

a detection unit for detecting whether or not the signal distribution unit is connected to the second communication interface;

a switch control unit for controlling the switch unit based on a detection result; and

a third communication interface configured and operable for performing communications with the medical device, wherein

the second communication interface is a connector which enables a connection to be made to the signal distribu-

tion unit by a connection system using a connector having a format different from that of the first communication interface,

the detection unit is a detection-use pin included in the connector formed by a plurality of pins, and the detection unit detects a change in a voltage state of the detection-use pin caused when the connector is connected to the signal distribution unit in order to detect whether or not the signal distribution unit is connected to the second interface, and

the switch control unit controls the switch unit to switch the communication lines from the first communication line to the second communication line when it is determined based upon the detection result of the detection unit that the signal distribution unit is connected to the second communication interface.

2. A communication conversion system, comprising:

a communication converter for converting a communication system and/or a communication protocol to enable communications between a medical device and a medical control device for controlling the medical device; and

a housing device capable of housing one or more communication converters, wherein the communication converter comprises:

a first communication interface configured and operable for communicating with the medical control device through a predetermined communication cable;

a second communication interface for use in communicating with the medical control device when the communication converter is housed in the housing device;

a switch unit switching communication lines to either a communication line through the first communication interface or a communication line through the second communication interface

a detection unit detecting whether or not a predetermined connector of the housing device is connected to the second communication interface;

a switch control unit controlling the switch unit based on a detection result; and

a third communication interface configured and operable for performing communications with the medical device; and

the housing device comprises:

a plurality of connectors capable of attaching and removing the second communication interface of the communication converter; and

a signal distribution unit distributing a signal from the medical control device to the communication converter attached to each of the connectors.

3. The system according to claim **2**, wherein

the second communication interface is connected to the connector by a connection system using a connector having a different format from that of the second communication interface.

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